The
Electrochemical
Society . . .

104th Meeting

Wrightsville Beach, North Carolina
September 13th-16th, 1953

LOCAL COMMITTEE

General Committee

FRANK L. LAQUE.....*General Chairman*

Registration and Local Transportation

W. G. DAWSON, *Chairman*

Finance

FRED A. LOWENHEIM, *Chairman*

Hotel and Plant Trips

R. B. TEEL, *Chairman*

Entertainment

H. T. PATERSON, *Chairman*

The Electrochemical Society

One Hundred and Fourth Meeting

Sunday through Wednesday

September 13, 14, 15, and 16, 1953

CONDENSED TECHNICAL PROGRAM

Battery

Monday morning, September 14—9:30 A.M.-12:00 M.—Round-table Discussion
(Anchor Room, Ocean Terrace Hotel)

Monday afternoon, September 14—2:00 P.M.-4:30 P.M.—Round-table Discussion
(Anchor Room, Ocean Terrace Hotel)

Corrosion (Abstracts 1-23)

Tuesday morning, September 15—9:00 A.M.-11:55 A.M.
(Crest Theatre)

Tuesday afternoon, September 15—2:00 P.M.-3:15 P.M.
(Crest Theatre)

Wednesday morning, September 16—9:00 A.M.-11:55 A.M.
(Crest Theatre)

Wednesday afternoon, September 16—2:00 P.M.-4:30 P.M.
(Crest Theatre)

Electrodeposition (Abstracts 24-38)

Monday morning, September 14—9:30 A.M.-12:00 M.
(Crest Theatre)

Monday afternoon, September 14—2:00 P.M.-4:10 P.M.
(Crest Theatre)

Tuesday morning, September 15—9:30 A.M.-11:30 A.M.
(Anchor Room, Ocean Terrace Hotel)

Electrothermics (Abstracts 39-44)

Tuesday morning, September 15—9:00 A.M.-12:00 M.
(Marine Room, Ocean Terrace Hotel)

Tuesday afternoon, September 15—2:00 P.M.-4:30 P.M.—Round-table Discussion
(Marine Room, Ocean Terrace Hotel)

GENERAL INFORMATION

Convention Headquarters will be at the **Ocean Terrace Hotel,** Wrightsville Beach, N. C.

Rates per person for rooms will be: Ocean Terrace Hotel, twin-bed double bedroom with adjoining bath, double $3.50, single $6.00; twin-bed double room with private bath, double $4.50, single $7.00. Pullen Hotel, double bedroom with connecting bath $4.00; double bedroom with private bath $4.50. At the following hotels a single room is $4.00, a double room $3.50: Kitty, Landis, Chandler, Hanover, Harrison's, and Creasy.

Requests for reservations should be made to: Mr. Jack Farrell, South Eastern North Carolina Beach Association, P.O. Box 698, Wilmington, N. C.

Sea Horse Institute Meeting

The annual meeting of the Sea Horse Institute will be held during the same week as the Society meeting on Wednesday through Friday, September 16-18. The Corrosion sessions of the Society, which are being held on Wednesday, September 16, will coincide with the first day of the meeting of the Sea Horse Institute.

REGISTRATION

The registration desk will be in the lobby of the Ocean Terrace Hotel. Registration periods are from 8:00 P.M. to 11:00 P.M. Sunday; 8:00 A.M. to 5:00 P.M. Monday; 9:00 A.M. to 5:00 P.M. Tuesday and Wednesday.

Registration fees are:

Members	$7.00	Students	$2.00
Ladies	$3.00	Nonmembers	$10.00

Sea Horse Institute members registering for Wednesday only $5.00

TRANSPORTATION

Because Wrightsville Beach is about ten miles from Wilmington, N. C., arrangements will be made for special buses to meet the major trains to transport members from the Wilmington depot to Wrightsville Beach.

STANDARD TIME

Wrightsville Beach, N. C., is on Eastern Standard Time. Consequently, all sessions and social functions are scheduled on Eastern Standard Time.

ROUND-TABLE DISCUSSIONS

The Battery Division has scheduled two round-table discussions: "Low Temperature Properties of Primary Cells" on Monday, September 14, from 9:30 A.M. to 12:00 M.; and "Positive Grid Corrosion" on Monday, September 14, from 2:00 P.M. to 4:30 P.M.

The Electrothermic Division has scheduled a round-table discussion "The Role of Electrothermics in the Preparation of Refractory Materials, Part I. Solid-Solid Reactions" on Tuesday, September 15, from 2:00 P.M. to 4:30 P.M.

PALLADIUM MEDAL LECTURE

Dr. Nathaniel Howell Furman of Princeton University will deliver the Palladium Medal Lecture at 4:00 P.M. on Tuesday, September 15, in the Crest Theatre. His lecture is entitled "Coulometry—Related Phenomena of Electrolysis and Current-Sweep Polarography."

LUNCHEON AND DINNERS

Monday Dinner

A barbecue dinner has been arranged for Monday at 6:30 P.M. at the Ocean Terrace Hotel.

Palladium Medal Banquet

A reception for the Palladium Medalist, Dr. Furman, will be held Tuesday at 6:30 at the Ocean Terrace Hotel. Following the reception, the Society banquet will be served. Music will be provided for dancing.

Wednesday Luncheon

The general Society luncheon will be held on Wednesday, September 16, at 12:30 P.M. at the Ocean Terrace Hotel. Judge Burney of the North Carolina Superior Court will give an account of some of his experiences as a trial judge.

PLANT TRIPS

Trips to International Nickel Company's Marine Corrosion Test Stations at Harbor Island and Kure Beach have been arranged. To make arrangements for these trips, please go to the registration desk. The trip to Kure Beach is scheduled for Wednesday at a cost of $1.00.

LADIES' PROGRAM

Monday evening—Barbecue dinner ($3.00)

Tuesday morning—A sightseeing tour of the area.

Tuesday evening—Palladium Medal Reception, Banquet, and dancing ($6.00)

Wednesday luncheon—The ladies are invited to attend the Society luncheon at 12:30 P.M. at the Ocean Terrace Hotel ($3.00).

BOARD AND COMMITTEE MEETINGS

Sunday, 10:00 A.M.—Meeting of the Ways and Means Committee in Room 109, Ocean Terrace Hotel.

Sunday, 2:00 P.M.—Meeting of the Board of Directors in Room 109, Ocean Terrace Hotel.

Monday, 5:00 P.M.—Meeting of the Sustaining Membership Committee in Room 109, Ocean Terrace Hotel.

Tuesday, 8:00 A.M.—Meeting of the Local Section Advisory Committee in Room 109, Ocean Terrace Hotel.

Tuesday, 5:00 P.M.—Meeting of the Editorial Staff in Room 109, Ocean Terrace Hotel.

LUNCHEONS AND BUSINESS MEETINGS OF DIVISIONS

Battery Division—will hold a luncheon and business meeting on Monday, September 14, at 12:15 P.M. at the Ocean Terrace Hotel.

Corrosion Division—will hold a luncheon on Tuesday, September 15, at 12:15 P.M. at the Kitty Hotel. At the conclusion of the luncheon, about 1:30 P.M., the Division's business meeting will be held.

Electrodeposition Division—will hold a luncheon on Tuesday, September 15, at 12:15 P.M. at the Ocean Terrace Hotel.

COST OF VARIOUS FUNCTIONS
(other than registration)

Division Luncheons	$ 3.00
Monday Dinner	$ 3.00
Tuesday Reception and Banquet	
(single)	$ 6.00
(couple)	$10.00
Wednesday Society Luncheon	$ 3.00
Trip to Kure Beach	$ 1.00

(Gratuities and taxes are included in above costs)

JOURNALS

Copies of the June, July, August, and September issues of the JOURNAL of The Electrochemical Society will be available at the registration desk. The price of single copies of the JOURNAL is $1.25 to members and $1.50 to nonmembers.

DISCUSSION

There will be no recordings made of oral discussions. Those contributing to the discussion of a paper and desiring their remarks published will be supplied with a printed form on which any discussion may be written. These forms should be given to the Secretary-Treasurer of the Division at the end of the session. The discussion will then be referred to the authors for reply. Written discussion will be accepted up to two months following publication of any article in the JOURNAL.

A discussion section is published semiannually in the JOURNAL.

MEETING ROOM SCHEDULES

	Monday		*Tuesday*		*Wednesday*	
Meetings	*A.M.*	*P.M.*	*A.M.*	*P.M.*	*A.M.*	*P.M.*
Corrosion			B	B	B	B
Battery	A	A				
Electrodeposition	B	B	A			
Electrothermic			C	C		

A—Meeting will be held in the Anchor Room, Ocean Terrace Hotel.

B—Meeting will be held in the Crest Theatre.

C—Meeting will be held in the Marine Room, Ocean Terrace Hotel.

Technical Program

Monday, September 14, 1953

9:00 A.M.—Formal Opening of 104th Convention, with Introduction by General Chairman F. L. LaQue and response by President R. J. McKay. (Crest Theatre).

BATTERIES

Round-Table Discussion

Monday, September 14, 1953

Low Temperature Properties of Primary Cells
J. J. Coleman, Chairman

(ANCHOR ROOM)
9:30 A.M. - 12:00 M.

12:15 P.M.—Battery Division Luncheon and Business Meeting at the Ocean Terace Hotel.

Batteries (cont'd.)

Round-Table Discussion

Monday, September 14, 1953

Positive Grid Corrosion
J. C. White, Chairman

(ANCHOR ROOM)
2:00 P.M. - 4:30 P.M.

CORROSION

Tuesday, September 15, 1953

with Frederick W. Fink presiding

(CREST THEATRE)

9:00 A.M.—"The Reaction of Nitrogen with, and the Diffusion of Nitrogen in, Beta Zirconium" by M. W. Mallett, Jack Belle, and B. B. Cleland, Battelle Memorial Institute, Columbus, Ohio. (Abstract No. 1)

9:25 A.M.—"The Reaction of Nitrogen with, and the Diffusion of Nitrogen in, Thorium" by A. F. Gerds and M. W. Mallett, Battelle Memorial Institute, Columbus, Ohio. (Abstract No. 2)

CORROSION

9:50 A.M.—"The Rate of Oxidation of Three Nickel-Chromium Heater Alloys between 500° and 900°C" by Earl A. Gulbransen and Kenneth F. Andrew, Westinghouse Research Laboratories, East Pittsburgh, Pa.
(Abstract No. 3)

10:15 A.M.—"The Surface Reaction between Oxygen and Thorium" by A. F. Gerds and M. W. Mallett, Battelle Memorial Institute, Columbus, Ohio. (Abstract No. 4)

10:40 A.M.—"The Protective Action of Pigments on Steel" by M. J. Pryor, Division of Metallurgical Research, Kaiser Aluminum and Chemical Corporation, Spokane, Wash.
(Abstract No. 5)

11:05 A.M.—"The Rate of Dissolution of Zinc in Chromic Chloride Solutions" by Cecil V. King and Natalie Mayer, Department of Chemistry, New York University, New York, N. Y.
(Abstract No. 6)

11:30 A.M.—"Corrosion Studies Using the Rotogenerative Technique" by Howard T. Francis, Electrochemistry Research, Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill. (Abstract No. 7)

12:15 P.M.—Corrosion Division Luncheon at the Kitty Hotel. At the conclusion of the luncheon, about 1:30 P.M., the Division's business meeting will be held.

Corrosion (cont'd.)

with Frederick W. Fink presiding

(CREST THEATRE)

2:00 P.M.—"Kinetics of Surface Reactions of Metals, I. Iron" by Norman Hackerman and Donald M. Sowards, Department of Chemistry, The University of Texas, Austin, Texas.
(Abstract No. 8)

2:25 P.M.—"The Tin-Steel Couple in Air-Free Citric Acid Solution" by E. L. Koehler, Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill.
(Abstract No. 9)

2:50 P.M.—"Corrosion Inhibition in Acid Solution" by Cecil V. King and Edward Hillner, Department of Chemistry, New York University, New York, N. Y. (Abstract No. 10)

CORROSION (cont'd.)

Special Report on Recent Electrochemical Activities Abroad

Tuesday, September 15, 1953

(CREST THEATRE)

3:15 P.M.—"Remarks Concerning Electrochemical Conventions" by Pierre Van Rysselberghe, Department of Chemistry, University of Oregon, Eugene, Oreg.

Palladium Medal Lecture

Tuesday, September 15, 1953

(CREST THEATRE)

4:00 P.M.—"Coulometry—Related Phenomena of Electrolysis and Current-Sweep Polarography" by N. H. Furman, Princeton University, Princeton, N. J.

Wednesday, September 16, 1953

Corrosion (cont'd.)
with Frederick W. Fink presiding

(CREST THEATRE)

9:00 A.M.—"Kinetics of Reaction of Copper with Hydrogen Sulfide and Molten Sulfur" by A. Dravnieks and R. S. Neymark, Standard Oil Company (Indiana), Chicago, Ill. (Abstract No. 11)

9:25 A.M.—"The Reaction of Silver Alloys with Sulfur in Mineral Oils, II. Examination of Reaction Films and Mechanism of Reaction" by H. O. Spauschus, R. W. Hardt, and R. T. Foley, TAP Laboratory, General Electric Company, Pittsfield, Mass. (Abstract No. 12)

9:50 A.M.—"Mechanism of Reaction of Aluminum and Aluminum Alloys with Carbon Tetrachloride" by Milton Stern and Herbert H. Uhlig, Corrosion Laboratory, Department of Metallurgy, Massachusetts Institute of Technology, Cambridge, Mass. (Abstract No. 13)

10:15 A.M.—"Anodic Behavior of Aluminum and Its Alloys in Sulfuric Acid Electrolytes" by Ralph B. Mason and Phyllis E. Fowle, Aluminum Research Laboratories, New Kensington, Pa. (Abstract No. 14)

10:40 A.M.—"The Anodic Behavior of Pure Aluminum in H_2SO_4," by J. V. Petrocelli, The Patent Button Company, Waterbury, Conn. (Abstract No. 15)

11:05 A.M.—"Radioactive Tracers in the Study of Pitting Corrosion on Aluminum" by P. M. Aziz, Institute for the Study of Metals, University of Chicago, Chicago, Ill.
(Abstract No. 16)

11:30 A.M.—"Studies on the Anodic Polarization of Zirconium and Its Alloys" by Mario Maraghini and Pierre Van Rysselberghe, Department of Chemistry, University of Oregon, Eugene, Oreg. (Abstract No. 17)

12:15 P.M.—Corrosion Division Luncheon and Business Meeting at the Kitty Hotel.

Corrosion (cont'd.)

with Frederick W. Fink presiding

(CREST THEATRE)

2:00 P.M.—"Galvanic Corrosion Behavior of Titanium and Zirconium in Sulfuric Acid Solutions" by David Schlain, Charles B. Kenahan, and Doris V. Steele, United States Department of the Interior, Bureau of Mines, College Park, Md. (Abstract No. 18)

2:25 P.M.—"Potentials of Iron, 18-8, and Titanium in Passivating Solutions" by Herbert H. Uhlig and Arthur Geary, Corrosion Laboratory, Department of Metallurgy, Massachusetts Institute of Technology, Cambridge, Mass.
(Abstract No. 19)

2:50 P.M.—"Corrosion Properties of Titanium in Marine Environments" by G. E. Hutchinson and H. B. Bomberger, Rem-Cru Titanium, Inc., Midland, Pa. (Abstract No. 20)

3:15 P.M.—"Results of Some Marine Atmosphere Corrosion Tests on Magnesium-Lithium Alloys" by P. D. Frost, F. W. Fink, J. H. Jackson, and H. A. Pray, Battelle Memorial Institute, Columbus, Ohio. (Abstract No. 21)

3:40 P.M.—"Galvanic Currents in the Electrode System Magnesium-Steel-Copper in Sea Water" by Thomas P. May, Corrosion Engineering Section, Development and Research Division, The International Nickel Company, Inc., New York, N. Y., and R. B. Teel, The International Nickel Company, Inc., Marine Corrosion Test Station, Harbor Island, N. C.
(Abstract No. 22)

4:05 P.M.—"Jet Impingement Tests" by P. T. Gilbert, Corrosion Section, The British Non-Ferrous Metals Research Association, London,

England, and F. L. LaQue, Corrosion Engineering Section, Development and Research Division, The International Nickel Company, Inc., New York, N. Y. (Abstract No. 23)

ELECTRODEPOSITION

Monday, September 14, 1953

with M. L. Holt presiding

(CREST THEATRE)

9:30 A.M.—"Radiometric Study of the Chromium-Sulfate Complex Formed in Chromium Plating Baths" by Ronald L. Sass and Stanley L. Eisler, Radiochemistry Section, Ordnance Corps, Rock Island Arsenal Laboratory, Rock Island, Ill. (Abstract No. 24)

10:00 A.M.—"A Study of the Variables Affecting the Particle Size of Electrodeposited Lead Powder" by James B. Crownover and Charles L. Mantell, Department of Chemical Engineering, Newark College of Engineering, Newark, N. J. (Abstract No. 25)

10:30 A.M.—"Adherent Electroplating on Molybdenum" by Robert M. Hansen and Charles L. Mantell, Department of Chemical Engineering, Newark College of Engineering, Newark, N. J. (Abstract No. 26)

11:00 A.M.—"Polarization Studies of Copper, Nickel, Titanium, and Some Copper and Nickel Alloys in Salt Solutions" by H. B. Bomberger, Rem-Cru Titanium, Inc., Midland, Pa., and F. H. Beck and M. G. Fontana, Corrosion Research Laboratories, The Ohio State University, Columbus, Ohio. (Abstract No. 27)

11:30 A.M.—"Electrodeposition of Cellulose" by Charles L. Mantell and Frank Cozzarelli, Department of Chemical Engineering, Newark College of Engineering, Newark, N. J. (Abstract No. 28)

Electrodeposition (cont'd.)

with C. A. Snavely presiding

(CREST THEATRE)

2:00 P.M.—"Electrodeposition of Nickel-Molybdenum Alloys from Aqueous Solutions" by D. W. Ernst and M. L. Holt, Chemistry Department, University of Wisconsin, Madison, Wis. (Abstract No. 29)

2:20 P.M.—"Electrodeposition of Cobalt-Molybdenum Alloys from Aqueous Solutions" by R. F. Amlie and M. L. Holt, Chemistry Department, University of Wisconsin, Madison, Wis. (Abstract No. 30)

2:40 P.M.—"Electrodeposition of a Lead-Tin Alloy Containing Six Per Cent Tin" by William S. Fischgrund and Charles L. Mantell, Department of Chemical Engineering, Newark College of Engineering, Newark, N. J. (Abstract No. 31)

3:10 P.M.—"Periodic Current Reversal in Plating Copper-Lead Alloys" by Nelson W. Hovey, John L. Griffin, and Albertine Krohn, University of Toledo, Toledo, Ohio. (Abstract No. 32)

3:40 P.M.—"The Effect of Periodic-Reverse Plating Variables on Density and Electrical Conductivity of Silver" by William H. Colner and Harold L. Schick, Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill. (Abstract No. 33)

Electrodeposition (cont'd.)

Tuesday, September 15, 1953
with M. L. Holt presiding

(ANCHOR ROOM)

9:30 A.M.—"Electronic Configuration in Electrodeposition from Aqueous Solutions, II. The Deposition Process" by Ernest H. Lyons, Jr., The Principia College, Elsah, Ill. (Abstract No. 34)

10:00 A.M.—"Electronic Configuration in Electrodeposition from Aqueous Solutions, III. Deposition from Certain Metal Complexes" by Ernest H. Lyons, Jr., The Principia College, Elsah, Ill., and John C. Bailar, Jr., and Herbert A. Laitinen, University of Illinois, Urbana, Ill. (Abstract No. 35)

10:30 A.M.—"The Interaction of Organic Compounds with the Surface during the Electrodeposition of Nickel" by Clayton C. Roth and Henry Leidheiser, Jr., Virginia Institute for Scientific Research, Richmond, Va. (Abstract No. 36)

11:00 A.M.—"Role of Shape of Colloidal Molecules in Electrolytic Metal Deposition" by S. Levy, 190 Madison Avenue, Perth Amboy, N. J. (Abstract No. 37)

11:30 A.M.—"The Theory of Transfer of Polarization in Codeposition of Metals" by Abner

Brenner, National Bureau of Standards, Washington, D. C. (Abstract No. 38)

12:15 P.M.—Electrodeposition Division Luncheon at the Ocean Terrace Hotel.

ELECTROTHERMICS

Tuesday, September 15, 1953

with I. E. Campbell presiding

(MARINE ROOM)

9:00 A.M.—"Research and Development in the Field of Carbides, Nitrides, Silicides, Alumides, and Borides for Aircraft Propulsion: A Status Report" by L. D. Richardson, Ceramic Section, Materiels Laboratory, WADC, Wright-Patterson Air Base, Ohio. (Abstract No. 39)

9:30 A.M.—"Bonding in the So-Called Interstitial Compounds" by Alan W. Searcy, Department of Chemistry, Purdue University, Lafayette, Ind. (Abstract No. 40)

10:00 A.M.—"The Stability of Refractory Silicides and Their Reactivity with Carbon and Nitrogen" by Leo Brewer and Oscar L. Kikorian, University of California, Berkeley, Calif. (Abstract No. 41)

10:30 A.M.—"Fabrication and Properties of Hafnium Carbide" by L. M. Doney, Ceramic Group, Oak Ridge National Laboratory, Oak Ridge, Tenn. (Abstract No. 42)

11:00 A.M.—"The Preparation and Examination of Beryllium Carbide" by M. W. Mallett, E. A. Durbin, M. C. Udy, D. A. Vaughan, and E. J. Center, Battelle Memorial Institute, Columbus, Ohio (Abstract No. 43)

11:30 A.M.—"Electric Sintering" by F. V. Lenel, Department of Metallurgical Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. (Abstract No. 44)

Electrothermics (cont'd.)

Round-Table Discussion

Tuesday, September 15, 1953

(MARINE ROOM)

2:00 P.M.-4:30 P.M.—Round-table Discussion "The Role of Electrothermics in the Preparation of Refractory Materials, Part I. Solid-Solid Reactions."

ABSTRACTS

CORROSION

ABSTRACT NUMBER 1

THE REACTION OF NITROGEN WITH, AND THE DIFFUSION OF NITROGEN IN, BETA ZIRCONIUM*

M. W. Mallett, Jack Belle, and B. B. Cleland

THE rate of reaction of nitrogen with high purity zirconium was determined for the temperature range of 975° to 1640°C at 1 atm pressure.

The reaction follows a parabolic law and the parabolic rate constant in cm^2/sec has been calculated to be: $k = 5.0 \times 10^3 \, e^{-48,000/RT}$, where 48,000 ± 1,500 cal/mole is the activation energy for the reaction.

The rate of diffusion of nitrogen in beta zirconium was obtained for the temperature range of 920° to 1640°C at 1 atm pressure. Diffusion-rate calculations based on a solution of the usual diffusion equation gave a diffusion coefficient, $D_\beta = 1.5 \times 10^{-2} \, e^{-30,700/RT}$ cm^2/sec. The energy of activation of diffusion, 30,700 cal/mole, has a probable error of 1000 cal/mole. The calculated entropy of activation for diffusion is 3.5 cal/mole degree.

The limiting solubilities of nitrogen in beta zirconium were determined from the diffusion data. The heat of solution of nitrogen in beta zirconium is 12,900 ± 500 cal/mole.

*Work done under Contract No. W-7405-eng-92 for the United States Atomic Energy Commission.

ABSTRACT NUMBER 2

THE REACTION OF NITROGEN WITH, AND THE DIFFUSION OF NITROGEN IN, THORIUM*

A. F. Gerds and M. W. Mallett

THE rate of reaction of nitrogen with thorium was determined for the temperature range of

670° to 1490°C at 1 atm pressure. The reaction follows a parabolic law, and the parabolic rate constant in cm^2/sec has been calculated to be $k = 5.9\ e^{24,300/RT}$, where 24,300 ± 1300 cal/mole is the activation energy of reaction.

The rate of diffusion of nitrogen in thorium was obtained over the temperature range of 845° to 1490°C at atmospheric pressure. The diffusion coefficient in cm^2/sec is $D = 2.1 \times 10^{-3}\ e^{-22,500/RT}$. The energy of activation of diffusion, 22,500 cal/mole, has a probable error of 1300 cal/mole.

The limiting solubilities of nitrogen in thorium were determined from the diffusion data. The heat of solution of nitrogen in thorium is 11,000 ± 400 cal/mole.

*Work done under Contract No. W-7405-eng-92 for the United States Atomic Energy Commission.

ABSTRACT NUMBER 3

THE RATE OF OXIDATION OF THREE NICKEL-CHROMIUM HEATER ALLOYS BETWEEN 500° AND 900°C

Earl A. Gulbransen and Kenneth F. Andrew

THE effect of time and temperature on the rate of oxidation of three nickel-chromium heater alloys was studied over the temperature range of 500° to 900°C, using a vacuum microbalance method. These alloys represent three stages in the historical development of alloys of this nominal composition during which the performance of these alloys has been increased 600 per cent. The oxidation rate data were interpreted in terms of the parabolic rate law.

Reasonable fit was found with the parabolic rate law for oxidations above 650°C. Below this temperature, the parabolic rate law constant varied strongly with time due to composition changes within the oxide and to growth of the oxide crystallite size.

The classical theory of diffusion was applied to the data, and heats and entropies of activations were calculated for the three alloys. Negative entropies of activation were obtained. When corrected for the entropy of vacancy formation, a positive entropy of diffusion was obtained for one alloy, but negative values for the other alloys.

A comparison of the rate of oxidation of the three alloys showed a maximum difference of 250 per cent, while the A.S.T.M. useful life tests

showed differences of 600 per cent. Comparison also showed that chromium reacts 4.1 times and nickel 12.6 times as fast with oxygen as alloy 13246.

ABSTRACT NUMBER 4

THE SURFACE REACTION BETWEEN OXYGEN AND THORIUM*

A. F. Gerds and M. W. Mallett

A STUDY has been made of the rate of surface reaction of arc-melted and rolled iodide thorium with oxygen in the temperature range of 850° to 1415°C at 1 atm pressure. Except for the initial period of the reaction, the data fit the parabolic rate law. The rate constant can be expressed as $k = 6 \times 10^7 e^{-63,300/RT}$ cm²/sec. The energy of activation, 63,300 cal/mole, has a probable error of 2100 cal/mole.

*Work done under Contract No. W-7405-eng-92 for the United States Atomic Energy Commission.

ABSTRACT NUMBER 5

THE PROTECTIVE ACTION OF PIGMENTS ON STEEL*

M. J. Pryor

THE action of aqueous extracts from litharge, metallic lead, red lead, basic lead carbonate, zinc, and zinc oxide on the corrosion of steel was investigated. It was found that litharge extracts inhibited the corrosion of steel completely, that the extracts from metallic lead and red lead inhibited for a short period, and that the extracts from basic lead carbonate, zinc, and zinc oxide lead had no protective action. The protective properties of the decanted extracts were in the same order as their reserve alkalinities. The litharge, metallic lead, and red lead extracts protected only when they contained dissolved air; when deaerated they attacked steel slowly. The passivity film formed in litharge extracts was found to be largely composed of γ-Fe_2O_3, no lead compounds being detected. It was considered

*Experimental work carried out at the National Research Council of Canada, Ottawa, Canada.

that the lead in the litharge extracts was present partly in the ionic form, possibly as $Pb(OH)^+$ ions, whereas the lead in extracts from metallic lead was present mainly as massive and colloidal lead hydroxide.

ABSTRACT NUMBER 6

THE RATE OF DISSOLUTION OF ZINC IN CHROMIC CHLORIDE SOLUTIONS*

Cecil V. King and Natalie Mayer

THE relative potentials of the zinc-zinc ion, chromous-chromic ion systems might lead one to expect smooth progress of the reaction $Zn + 2Cr^{+++} \rightarrow Zn^{++} + 2Cr^{++}$. However, various other reactions are possible, and the dissolution or corrosion process is complicated; it is electrochemical in nature and in some solutions rapid enough to permit transport control of the rates. The dissolution rate is highly dependent on the form of chromic ion present, on pretreatment of the metal surface, in some solutions on the acidity, and under some conditions the main reaction is hydrogen evolution with little reduction of chromic ion.

*Work done under Contract AT (30-1)-816 of the U. S. Atomic Energy Commission with New York University.

ABSTRACT NUMBER 7

CORROSION STUDIES USING THE ROTOGENERATIVE TECHNIQUE

Howard T. Francis

IN THE rotogenerative technique, a rotating cylindrical corrosion specimen is scanned by a small, fixed reference electrode; the signal produced is presented on an oscilloscope. The pattern (voltage vs. distance) reflects the distribution of anodic and cathodic zones on the specimen.

This paper reports a survey of a number of metals (iron, zinc, brass, aluminum, magnesium) exposed to typical corrosion media (distilled

water, tap water, 3.5% NaCl, acid, alkali). Also illustrated are inhibitor action and cathodic protection.

ABSTRACT NUMBER 8

KINETICS OF SURFACE REACTIONS OF METALS

I. Iron

Norman Hackerman and Donald M. Sowards

THE reaction of iron in a nitrogen-dilute acetic acid spray at 34°C was studied. The reaction rate was found to be a function of solution acidity, rate of flow and replenishment of liquid on the metal, temperature, and the nature of the adherent reaction products. The change in reactivity, as well as changes in the type of localized activity, with changing exposure conditions may be satisfactorily explained in terms of the defect structure of the film on the metal.

ABSTRACT NUMBER 9

THE TIN-STEEL COUPLE IN AIR-FREE CITRIC ACID SOLUTION

E. L. Koehler

IN AIR-FREE citric acid solution, specimens of uncoupled black plate were found to evolve hydrogen at a rate equivalent to that of solution of the steel. Additions of up to 0.3 grams $SnCl_2 \cdot 2H_2O$ per liter progressively decrease corrosion rates.

Tin is anodic to steel, and protects it sacrificially in solutions containing dissolved tin. Hydrogen evolution is decreased by coupling, not solely by inhibition, but also by an apparent shift in the anodic polarization curve of the steel when it is coupled to tin.

All observed effects on the corrosion rates in this medium, whether traceable to the steel, dissolved tin inhibitor, or by coupling to tin, appear to be the results of variations in the anodic properties of the steel.

ABSTRACT NUMBER 10

CORROSION INHIBITION IN ACID SOLUTION*

Cecil V. King and Edward Hillner

CYLINDERS of iron, zinc, and cadmium were rotated in a highly corrosive solution of acid containing nitrate ion as a depolarizer, as described previously. Three kinds of inhibitors were added to the solution: (*a*) dichromate ion plus complexing or chelating agents for metal ions; (*b*) a wetting or emulsifying agent which is strongly adsorbed; and (*c*) a reagent which forms a very insoluble precipitate with ferrous and ferric ions. Measurements of the effectiveness of these inhibitors are given.

*Work done under U. S. Atomic Energy Commission Contract No. AT (30-1)-816 with New York University.

ABSTRACT NUMBER 11

KINETICS OF REACTION OF COPPER WITH HYDROGEN SULFIDE AND MOLTEN SULFUR

A. Dravnieks and R. S. Neymark

THE rate of formation of Cu_2S scale on copper in hydrogen sulfide above 86°C increases with scale thickness, exhibiting heretofore unfamiliar kinetics which are caused by an additional rate-limiting mechanism at the scale surface. In molten sulfur above 220°C, the corrosion is uniform and parabolic. The products contain CuS, Cu_2S, and $Cu_{1.8}S$. Below 220°C, rapid initial pitting is observed; this ceases suddenly, and further attack is slow. A possible mechanism is advanced.

ABSTRACT NUMBER 12

THE REACTION OF SILVER ALLOYS WITH SULFUR IN MINERAL OILS

II. Examination of Reaction Films and Mechanism of Reaction

H. O. Spauschus, R. W. Hardt, and R. T. Foley

REACTION product films grown on silver alloys by reaction with sulfur in mineral oil

were examined by spectroscopic, x-ray, and electron-diffraction techniques. Interpretation of the results leads to a mechanism of reaction in which the rate-determining step during the steady phase is diffusion through a strained interfacial zone of constant thickness, comprised of the sulfide of the alloying element dissolved in beta silver sulfide, altering the number of normal lattice defects. The sulfide of thallium, which unlike all the other alloying elements yields a sulfide with a cation/anion ratio similar to silver sulfide, is exceptional.

ABSTRACT NUMBER 13

MECHANISM OF REACTION OF ALUMINUM AND ALUMINUM ALLOYS WITH CARBON TETRACHLORIDE

Milton Stern and Herbert H. Uhlig

THE reaction of aluminum and its alloys in boiling carbon tetrachloride is explained by a free radical chain mechanism. The effects of oxygen, water, hydrogen chloride, corrosion products, inhibitors, magnesium alloy additions, and behavior of aluminum in CCl_4 vapor are discussed.

Aluminum containing manganese or magnesium reaches a limiting weight loss which is a function of the solution volume to specimen area ratio. This behavior is caused by the formation of a protective corrosion product layer formed by reaction of the metal with a critical minimum concentration of soluble corrosion products.

ABSTRACT NUMBER 14

ANODIC BEHAVIOR OF ALUMINUM AND ITS ALLOYS IN SULFURIC ACID ELECTROLYTES

Ralph B. Mason and Phyllis E. Fowle

THIS paper deals with the main factors affecting the rate of solution of anodic oxide coatings on aluminum as they are being formed in sulfuric acid electrolytes. Conditions favoring high coating ratios or thick hard abrasion-resistant coatings have been investigated. Low

temperatures, high current densities, which permit a shorter time of immersion in the electrolyte, and the addition of substances such as oxalic acid to the electrolyte, favor the formation of such coatings. This has been mainly an investigation of the competition between the rate of formation and the rate of solution of the coatings.

ABSTRACT NUMBER 15

THE ANODIC BEHAVIOR OF PURE ALUMINUM IN H_2SO_4

J. V. Petrocelli

THE anodic behavior of pure aluminum in H_2SO_4 at relatively low voltages has been studied. Conventional d-c polarization curves have been obtained; in addition, a-c impedance measurements have been made at each of the various d-c voltages by superimposing a small a-c voltage on the d-c voltage and measuring the impedance with an a-c bridge. The resulting data have been used to calculate the capacitance and resistance at the metal-solution interface. It is shown that these latter parameters may be used in a qualitative way to determine the thickness of the "barrier layer film" and a probable mechanism for the dissolution reaction.

ABSTRACT NUMBER 16

RADIOACTIVE TRACERS IN THE STUDY OF PITTING CORROSION ON ALUMINUM

P. M. Aziz*

RADIOACTIVE cobalt and lead ions in solution have been used to study the distribution of local cathodes on aluminum alloy specimens which were actively pitting, and to study the processes of film breakdown and repair on aluminum alloy specimens after introducing them into a corrosive environment. In the study of pitting, radioactive ions were introduced into the solution after pitting of the sample had proceeded for a predetermined length of time. The tracer was then permitted to plate out onto the local

*Present address: Aluminum Laboratories Limited, P. O. Box 84, Kingston, Ontario, Canada.

cathodes and, after washing and drying, autoradiographs of the surface were prepared. The results indicate that after a pit is a few hours old it is surrounded by a ring of cathodic surface and outside this is an annular ring of passive surface which prevents the lateral expansion of the corrosive attack, the remainder of the surface being cathodic. In the study of the mechanism of film breakdown and repair, samples with different surface treatments were placed in the solution and radioactive ions were introduced after various predetermined times, exchange permitted to take place, the samples washed and dried, and autoradiographs prepared of the surface. The results indicate that, on contact with the solution, the surface oxide film breaks down and is then repaired by reaction with the solution.

ABSTRACT NUMBER 17

STUDIES ON THE ANODIC POLARIZATION OF ZIRCONIUM AND ITS ALLOYS

Mario Maraghini and Pierre Van Rysselberghe

ANODIC polarization of zirconium and some alloys was studied in several electrolytes. In chloride solutions, corrosion potentials below that of oxygen evolution are established, but the addition of nitrate in the ratio 3 to 5 to chloride brings the potential above that of oxygen evolution. The formation of the film along the three portions of the potential-time curves (initial rapid increase, evolution of oxygen at practically constant potential, final rapid increase) was studied in detail, and quantitative information about local currents and the efficiency of the film building process was obtained.

ABSTRACT NUMBER 18

GALVANIC CORROSION BEHAVIOR OF TITANIUM AND ZIRCONIUM IN SULFURIC ACID SOLUTIONS

David Schlain, Charles B. Kenahan, and Doris V. Steele

ELECTRODE potential and galvanic current measurements in sulfuric acid up to 2*N* in concentration indicate that, while titanium is

less noble than type 302 stainless steel, a titanium-stainless steel couple generates virtually no current in the presence of air. Weight losses show that the corrosion resistance of titanium is increased by contact with stainless steel. Titanium is more noble than common aluminum alloys in 0.1N acid in the presence of air, and sizeable currents are produced in a couple. However, the titanium member of such a couple exhibits lower corrosion resistance. Zirconium is not affected by contact with stainless steel or aluminum alloys.

ABSTRACT NUMBER 19

POTENTIALS OF IRON, 18-8, AND TITANIUM IN PASSIVATING SOLUTIONS

Herbert H. Uhlig and Arthur Geary

POTENTIAL measurements of iron in chromate solutions indicate adsorption of chromates in accord with the Langmuir adsorption isotherm. $C/\triangle E$ vs. C is linear, where C is concentration of chromate and $\triangle E$ is corresponding change of potential. Similar linear relations have been found for organic inhibitors which function by adsorbing. Data are presented for 18-8 and titanium in sulfuric acid containing cupric and ferric ions, and in sodium hydroxide, and also for 18-8 as a function of oxygen partial pressure. The data point strongly toward a mechanism of passivity for each of the metals studied, based on adsorption of the passivator. Pitting tendencies of 18-8 and titanium are discussed in relation to their potential behavior.

ABSTRACT NUMBER 20

CORROSION PROPERTIES OF TITANIUM IN MARINE ENVIRONMENTS

G. E. Hutchinson and H. B. Bomberger

DATA are presented on the behavior of commercially pure titanium and several common structural metals exposed up to five years at Kure Beach, N. C. The tests included exposures to the atmosphere, quiet and flowing sea water, jet impingement, stress corrosion, and galvanic couples. These tests indicate that titanium is completely unaffected by marine environments.

ABSTRACT NUMBER **21**

RESULTS OF SOME MARINE ATMOSPHERE CORROSION TESTS ON MAGNESIUM-LITHIUM ALLOYS

P. D. Frost, F. W. Fink, J .H. Jackson, and H. A. Pray

MAGNESIUM-LITHIUM binary alloys which contain just enough lithium (about 11 weight per cent) to produce a single-phase alloy have shown surprisingly good resistance to corrosion in 3 per cent NaCl solution. Three higher strength two-phase alloys containing aluminum and zinc as major alloying elements were exposed for 32 months to the seacoast atmosphere near Daytona Beach, Florida. Control samples of commercial AZ31A alloy (Mg-3% Al-1% Zn) were exposed at the same time. All alloys were in the form of 4 x 6 x 0.064-in. panels. The AZ31A sheet had corrosion resistance only slightly superior to that of an alloy containing Mg-8.7 per cent, Li-5 per cent, Al-8 per cent Zn. The other two alloys, Mg-8.8 per cent, Li-7 per cent, Al-0.05 per cent, Sn-1 per cent, Mn and Mg-8.8 per cent, Li-7 per cent, Al-1 per cent Sn, had much poorer corrosion resistance.

ABSTRACT NUMBER **22**

GALVANIC CURRENTS IN THE ELECTRODE SYSTEM MAGNESIUM-STEEL-COPPER IN SEA WATER

Thomas P. May and R. B. Teel

THE galvanic current in a steel-copper couple in flowing sea water was studied with respect to the influence of a third, more anodic electrode, magnesium. Initial increments in magnesium current led to reductions of steel current, but did not change the copper current. Subsequent increases reversed the steel current and increased the copper current. Potentials of the steel and copper were measured. The results are discussed with reference to the mechanism of cathodic protection.

ABSTRACT NUMBER **23**

JET IMPINGEMENT TESTS

P. T. Gilbert and F. L. LaQue

THIS paper describes the operation of jet impingement test apparatus in the laboratories of The British Non-Ferrous Metals Research Association in London and at International Nickel Company's Marine Corrosion Test Station at Harbor Island, N. C. Certain differences in results obtained on the same materials in the two laboratories are discussed with relation to differences in testing conditions. Particular attention is given a comparison between results secured with water that is recirculated and used over and over again, as is the practice in the B.N.F.M.R.A. laboratories, with results obtained with water that is passed through the apparatus only once, as has been the regular practice at Harbor Island. Effects of air bubbles, jet velocity, and other incidental factors are also discussed. The relationship between test results and service experience is considered. It is concluded that test conditions established for use in the B.N.F.M.R.A. laboratory, using recirculated water, are too drastic when applied at Harbor Island, using water that is not recirculated, to permit proper comparisons of materials. The testing conditions at Harbor Island can be modified to yield results in harmony with the B.N.F.M.R.A. results either by reducing the jet velocity or by recirculating the water.

ELECTRODEPOSITION

ABSTRACT NUMBER **24**

RADIOMETRIC STUDY OF THE CHROMIUM-SULFATE COMPLEX FORMED IN CHROMIUM PLATING BATHS*

Ronald L. Sass and Stanley L. Eisler

TESTS conducted to determine the ionic nature of the coordination complex formed and the amount of sulfate so complexed are described. It

*The opinions or assertions contained herein are not to be construed as being official or reflecting the views of the Department of the Army.

was found that the chromium-sulfate complex formed is cationic in behavior and can be removed from the plating solution by employing the appropriate ion exchange media. Approximately seven per cent of the total sulfate is bound up in the complex after electrolysis. The formation of a large complex ion is indicated by the fact that the per cent of sulfate regained from the resin column is considerably less than and independent of the amount of trivalent chromium regained.

ABSTRACT NUMBER 25

A STUDY OF THE VARIABLES AFFECTING THE PARTICLE SIZE OF ELECTRODEPOSITED LEAD POWDER

James B. Crownover* and Charles L. Mantell

AT THE present time, electrolytic lead powder is not produced in the United States. The three major manufacturers of lead powder, the National Lead Company, Perth Amboy, New Jersey, the Metals Disintegrating Company, Elizabeth, New Jersey, and the Glidden Company, Hammond, Indiana, use atomization processes. To date, very little work has been done on the preparation of lead powder by electrolytic means. It is hoped that this thesis will serve as a starting point and guide for future studies of electrolytically deposited lead powder.

*Present address: Titanium Division, National Lead Company, Sayreville, N. J.

ABSTRACT NUMBER 26

ADHERENT ELECTROPLATING ON MOLYBDENUM

Robert M. Hansen* and Charles L. Mantell

FOUR detailed methods of securing adherent plating on molybdenum are described in detail with regard to preliminary surface preparation and plating methods.

*Present address: Louisiana State University, Baton Rouge, La.

ABSTRACT NUMBER 27

POLARIZATION STUDIES OF COPPER, NICKEL, TITANIUM, AND SOME COPPER AND NICKEL ALLOYS IN SALT SOLUTIONS

H. B. Bomberger, F. H. Beck, and M. G. Fontana

POLARIZATION characteristics were determined for some metals and alloys in flowing salt solutions. Relationships between potential and time, potential and applied current, applied current and corrosion rate, and solution velocity and corrosion rate were considered. Copper and brass anodes dissolved readily. Nickel and copper-nickel alloys exhibited an anodic overvoltage. Titanium anodes resisted dissolution by film growth and extensive polarization.

ABSTRACT NUMBER 28

ELECTRODEPOSITION OF CELLULOSE

Charles L. Mantell and Frank Cozzarelli

CELLULOSE has been plated at the anode from solutions containing approximately one per cent of cellulose, where the solvent is an alkaline sodium zincate modified by addition of urea.

ABSTRACT NUMBER 29

ELECTRODEPOSITION OF NICKEL-MOLYBDENUM ALLOYS FROM AQUEOUS SOLUTIONS*

D. W. Ernst and M. L. Holt

NICKEL-MOLYBDENUM alloys can be electrodeposited from aqueous solutions containing nickel sulfate, sodium molybdate, sodium citrate, and ammonium hydroxide. The effects of *p*H, concentration, temperature, and cathode current density on cathode current efficiency and on the composition of the alloy deposits were studied. A plating solution, containing 0.3 mole/liter of nickel sulfate, 0.2 mole/liter of sodium molybdate, 0.3 mole/liter of sodium citrate, and am-

*Work done under Contract No. DA 11-022-ORD-656 for the Office of Ordnance Research.

monium hydroxide to *p*H 10-11, showed a current efficiency of about 80 per cent when electrolyzed at 10 amp/dm². The resulting alloy deposits were bright and adherent, and contained about 20 per cent molybdenum.

ABSTRACT NUMBER **30**

ELECTRODEPOSITION OF COBALT-MOLYBDENUM ALLOYS FROM AQUEOUS SOLUTIONS*

R. F. Amlie and M. L. Holt

AQUEOUS solutions containing cobalt sulfate, sodium molybdate, and either sodium citrate or malic acid were found suitable for the electrodeposition of cobalt-molybdenum alloys. The effects of *p*H, concentration, temperature, and cathode current density on the current efficiency and on the composition of the alloy deposits were investigated. The Hull cell was used to obtain qualitative information, and regular plating procedures were used for quantitative information. A comparison of similar nickel-molybdenum and cobalt-molybdenum baths is also included.

*Work done under Contract No. DA 11-022-ORD-656 for the Office of Ordnance Research.

ABSTRACT NUMBER **31**

ELECTRODEPOSITION OF A LEAD-TIN ALLOY CONTAINING SIX PER CENT TIN

William S. Fischgrund* and Charles L. Mantell

THE most stable solution for depositing a six per cent tin deposit has the following composition: 0.11*N* stannous tin; 0.89*N* lead metal; and 0.5 g/l peptone. This solution can be operated at room temperatures, and current densities from 10 to 45 amp/ft² are permissible.

*Present address: Wright Aeronautical Division, Woodridge, N. J.

ABSTRACT NUMBER **32**

PERIODIC CURRENT REVERSAL IN PLATING COPPER-LEAD ALLOYS

Nelson W. Hovey, John L. Griffin, and Albertine Krohn

APPARATUS based on the commutator principle was designed and constructed to convert direct current to square-wave alternating current, and was applied in electrodepositing copper-lead alloys from a cyanide-tartrate solution. The procedure was successful in eliminating the nodules which occurred in alloy deposits obtained in previous studies using this type of bath.

ABSTRACT NUMBER **33**

THE EFFECT OF PERIODIC-REVERSE PLATING VARIABLES ON DENSITY AND ELECTRICAL CONDUCTIVITY OF SILVER

William H. Colner and Harold L. Schick

IN A STUDY sponsored by Squier Signal Laboratory aimed at improving microwave surfaces, several variables of periodic-reverse plating were investigated as affecting the density and electrical conductivity (and in some cases, smoothness) of electroformed silver specimens.

The following variables were studied: forward current density, reverse current density, forward to reverse time ratio, cycling speed, bath temperature, presence of brighteners, and annealing. Conditions which maximize density and conductivity were found for both periodic-reverse and direct current plates. With periodic reverse, better properties were obtained.

ABSTRACT NUMBER **34**

ELECTRONIC CONFIGURATION IN ELECTRODEPOSITION FROM AQUEOUS SOLUTIONS

II. The Deposition Process

Ernest H. Lyons, Jr.

IT IS proposed that electrodeposition proceeds through an intermediate complex ion adsorbed on the cathode by a coordinated bridge. Subsequently, the bridge is eliminated and a metallic bond established. By applying the Pauling theory of the metallic state, the reversible deposition of post-transition metals and irreversible deposition of the transition metals are explained. A close correlation with electron-transfer reactions is shown. Inclusions in deposits represent residual coordinated groups, in agreement with the results of recent studies.

ABSTRACT NUMBER **35**

ELECTRONIC CONFIGURATION IN ELECTRODEPOSITION FROM AQUEOUS SOLUTIONS

III. Deposition from Certain Metal Complexes

Ernest H. Lyons, Jr., John C. Bailar, Jr., and Herbert A. Laitinen

THE cathodic behavior of cobalt, nickel, copper, and zinc complexes of 8-hydroxyquinoline-5-sulfonic acid, 1,10-phenanthroline, glycine, naphthalenediamines, tetramethylethylenediamine, and dimethylglyoxime was investigated by determining cathode efficiencies and polarograms. Deposition was not obtained from ions believed to have hybridized orbitals involving the penultimate electron shell, that is, from the "inner orbital" complexes of Taube. Deposits were obtained from "outer orbital" ions, thus confirming the rule previously proposed. Evidence is given that copper, as well as cobalt and nickel, forms ions of both types.

ABSTRACT NUMBER **36**

THE INTERACTION OF ORGANIC COMPOUNDS WITH THE SURFACE DURING THE ELECTRODEPOSITION OF NICKEL

Clayton C. Roth and Henry Leidheiser, Jr.

CORRELATIONS were drawn between the structures of 76 organic compounds and their effect on the cathode potential. Brittleness,

peeling, and cracking of the deposit occurred at high cathode potentials. Adsorption experiments with Raney nickel and measurements of the electrode potential in 1*N* HCl indicated that the compounds most effective in increasing the cathode potential were readily adsorbed by nickel. X-ray measurements indicated that the compounds which affected the potential also interfered with crystal growth.

ABSTRACT NUMBER 37

ROLE OF SHAPE OF COLLOIDAL MOLECULES IN ELECTROLYTIC METAL DEPOSITION

S. Levy

THE changes in electrolyte at the cathode caused by two types of colloidal molecules are discussed. Specific mechanisms of influence on electrodeposits are suggested for each type: the elongated and the spherelike molecules.

ABSTRACT NUMBER 38

THE THEORY OF TRANSFER OF POLARIZATION IN CODEPOSITION OF METALS

Abner Brenner

(NO ABSTRACT RECEIVED)

ELECTROTHERMIC

ABSTRACT NUMBER 39

RESEARCH AND DEVELOPMENT IN THE FIELD OF CARBIDES, NITRIDES, SILICIDES, ALUMIDES, AND BORIDES FOR AIRCRAFT PROPULSION: A STATUS REPORT

L. D. Richardson

A BRIEF discussion will be given of why these special materials are needed and how the present state of the art has been reached. General service requirements, which are constantly changing, will be described. A discussion will be given of the work in progress in the various areas of interest. Possibilities for the future will be indicated.

ABSTRACT NUMBER 40

BONDING IN THE SO-CALLED INTERSTITIAL COMPOUNDS

Alan W. Searcy

THE unusual properties of the so-called interstitial carbides, nitrides, and oxides have been explained recently as arising from the presence of directed valence bonds and of metallic bonds in these phases. Properties identical with those characteristic of these interstitial compounds are shown by borides and silicides which do not have the characteristic interstitial structures and for which a directed valence bond theory does not appear to be applicable. The structures of metal-like hybrides, borides, carbides, nitrides, oxides, silicides, and sulfides can all be explained in terms of preferred atomic packing, which appears to explain the observed structures more satisfactorily than a directed valence bond theory. The high stability and great hardness of these compounds can be explained in terms of the high bond density arising from the efficient packing of small atoms with large atoms.

ABSTRACT NUMBER 41

THE STABILITY OF REFRACTORY SILICIDES AND THEIR REACTIVITY WITH CARBON AND NITROGEN

Leo Brewer and Oscar L. Kikorian

IN AN effort to fix approximately the heats of formation of the refractory silicides of Ti, Zr, Nb, Ta, Mo, and W, these metals were heated in pairs with silicon to determine which metal had the greatest affinity for silicon. Also the various silicide phases of these metals were heated with carbon or nitrogen to determine the composition triangles of stable phases of the ternary phase

diagrams. The Zr and Ta silicides appear to have the greatest thermodynamic stability. The Ti silicides have somewhat less stability and the Mo and W silicides have the lowest thermodynamic stability of these elements.

ABSTRACT NUMBER 42

FABRICATION AND PROPERTIES OF HAFNIUM CARBIDE

L. M. Doney

A SURVEY is presented of the preparation and properties of hafnium carbide. Various methods for the synthesis of the material are discussed, not all of which were successful. Fabrication by hot pressing was used as a means of consolidation. In general, induction heating was employed in both synthesis and hot pressing. X-ray structure data were obtained. Some physical and mechanical properties were determined. One of the outstanding characteristics of hafnium carbide is its hardness—2900 Vickers—as compared with 2400 Vickers for boron carbide. This material is quite brittle.

ABSTRACT NUMBER 43

PREPARATION AND EXAMINATION OF BERYLLIUM CARBIDE

M. W. Mallett, E. A. Durbin, M. C. Udy, D. A. Vaughan, and E. J. Center

THE properties of beryllium carbide were studied to determine its suitability as a high temperature refractory. Various methods of preparing it were tried, and a number of the physical and chemical properties of the resulting products were determined. Lots containing 85 wt per cent of useful product were prepared by the beryllium metal-carbon reaction. Because the material was to be fabricated into refractory bodies, particular attention was paid to the chemical analysis for unreacted BeO, beryllium metal, and free carbon; x-ray diffraction identification of the various phases present; and microscopical examination for mineral composition, crystal size, and crystal habit.

As a refractory, beryllium carbide has several

disadvantages. It tends to hydrolize in atmospheric moisture and must be protected against both oxygen and nitrogen, when heated.

ABSTRACT NUMBER **44**

ELECTRIC SINTERING

F. V. Lenel

(NO ABSTRACT RECEIVED)

SPRING MEETING

at the

LA SALLE HOTEL

Chicago, Illinois

May 2, 3, 4, 5, and 6, 1954

SESSIONS ON

Electric Insulation

Electronics

Electro-Organics

Industrial Electrolytic

Theoretical Electrochemistry

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not later than February 1, 1954

in order to be included in the program.

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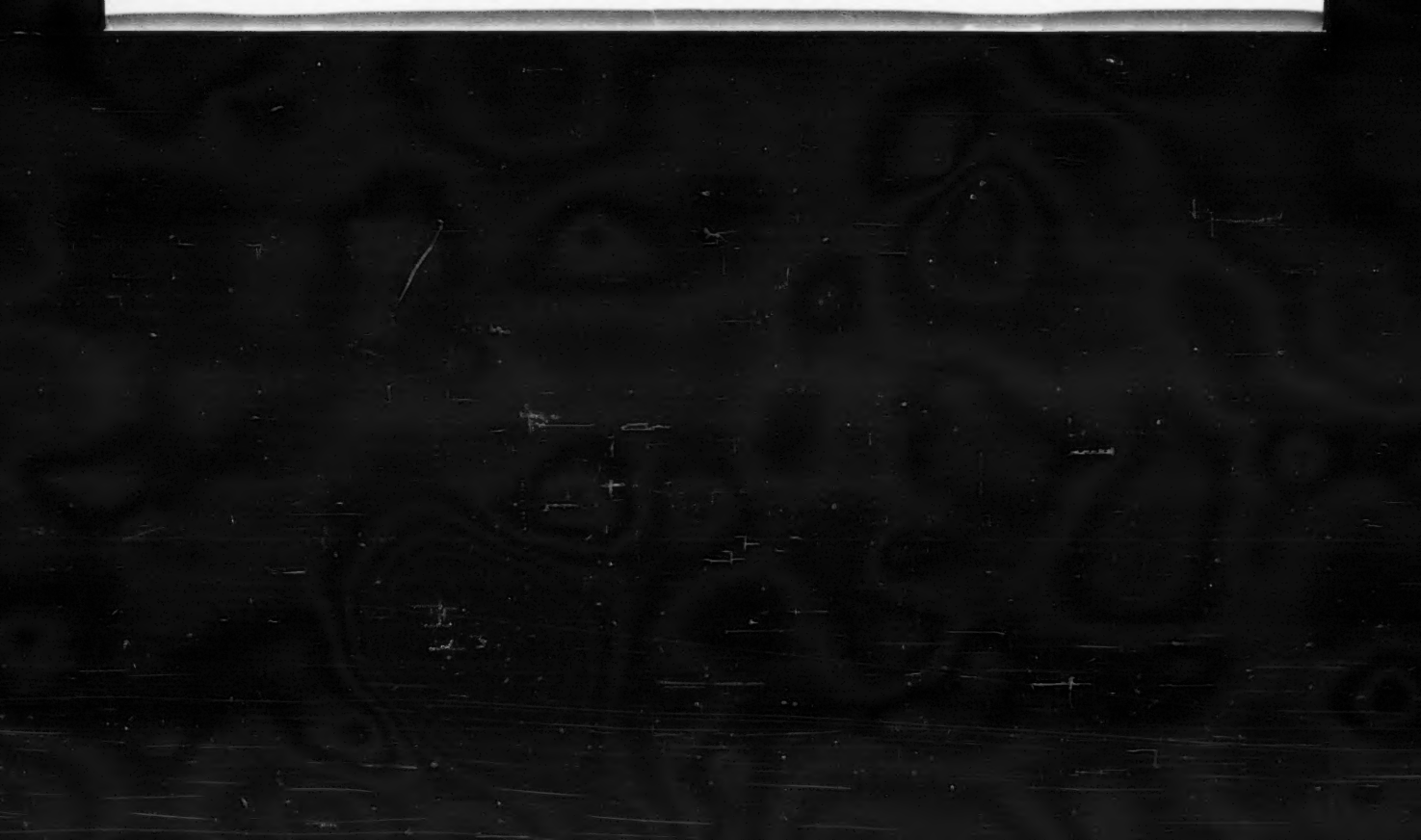

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